Clinical-electroencephalographic analysis of brain bioelectrical activity in children with myelomeningocele and internal hydrocephalus

Okurowska-Zawada B, Sobaniec W, Kułak W, Śmigielska-Kuzia J, Paszko-Patej G, Sienkiewicz D, Sendrowski K*

Department of Pediatric Neurology and Rehabilitation, Medical University of Białystok, Poland

Abstract

Purpose: The aim of the current study was the clinical and electroencephalographic (EEG) analysis of the brain bioelectrical activity in patients with myelomeningocele and internal hydrocephalus.

Material and methods: The present study included 86 children (44 boys and 42 girls) with myelomeningocele. The children were aged 1-17 years (mean 7±4.4 years). Thoracic myelomeningocele was identified in 24 children (28%), lumbar in 53 (62%) and sacral in 9 cases (10%).

Results: The standard EEG examination performed in the waking state revealed generalized changes in 53 patients (62%), including 19 (79%) with thoracic, 28 (53%) with lumbar and 6 (66%) with sacral myelomeningocele. Approximately 70% of the patients underwent ventriculoperitoneal shunting and epilepsy was found in 27 children (31.4%). The prevalence of changes detected in the left temporal region did not differ between the respective myelomeningocele types. No correlations were noted between the degree of spinal cord injury and the changes observed in the left temporal region in EEG recording. Likewise, changes found in the centroparietal region in EEG did not correlate with the site of myelomeningocele. Focal changes in the frontotemporal ($p<0.0067$) and right temporal region ($p<0.0314$) showed a positive correlation with the degree of spinal cord injury and were most frequent in patients with thoracic myelomeningocele.

Conclusion: The analysis of EEG might facilitate evaluation and prognosis of epileptic seizures in children with myelomeningocele and internal hydrocephalus.

* CORRESPONDING AUTHOR:
Department of Pediatric Neurology and Rehabilitation,
Medical University of Białystok
15-274 Białystok, ul. Waszyngtona 17, Poland
Tel/fax: +48 85 7450812
e-mail: zawada.bozena @wp.pl (Bożena Okurowska-Zawada)

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Introduction

Myelomeningocele is a congenital defect involving insufficient closure of the spine, arising during fetal development of the spinal cord and vertebral column [1,2]. It affects 1 out of every 1 000 alive newborns and is thus the second most common congenital defect (after Down syndrome) [3,4]. Its incidence in Poland accounts for 2.05-2.68 per 1 000 births. Most children with neural tube defects are born in the regions of Białystok, Bielsk Podlaski, Łomża and Siedlce [4]. Exacerbation of locomotor disorder symptoms is due to body growth. New pareses or paralyses and sensation defects are due to the extension of the spinal cord and nerve roots as a result of adhesions formed between nerve elements and other surrounding elements. Factors that alter the neurological state include medullary ischemia, infection or spina bifida repair [5,6]. Approximately 25% of newborns with myelomeningocele have congenital hydrocephalus. According to Barszcz [6], epileptic seizures in children with myelomeningocele and hydrocephalus can be caused by the drainage system and subsequent brain damage, valvar dysfunction leading to increased endocranial pressure and infections of the central nervous system. It is estimated that epilepsy in children suffering from myelomeningocele and internal hydrocephalus occurs in 20% of the cases with ventriculoperitoneal shunt insertion, being found only in 2% of the patients without shunting [7-11]. EEG may facilitate evaluation and prognosis of epileptic seisures in children with myelomeningocele and internal hydrocephalus.

Study objective: clinical-electroencephalographic analysis of the bioelectrical activity of the brain in children with myelomeningocele and internal hydrocephalus.

***Table 1*. Incidence of hydrocephalus and treatment with ventriculoperitoneal shunt valve**

Incidence of hydrocephalus	Ventriculoperitoneal shunt valve				Total	
	No		Yes			
	N	%	N	%	N	%
Absent	16	100	0	0	16	100
Present	21	30	49	70	70	100
N	37	43	49	57	86	100

p<0.00001

***Table 2*. Frequency of drainage system revision and myelomeningocele location**

Location of myelomeningocele	Revision of the drainage system						Total	
	Lack		Once		More than once			
	N	%	N	%	N	%	N	%
Thoracic	3	13	7	29	14	58	24	100
Lumbar	37	70	10	19	6	11	53	100
Sacral	9	100	0	0	0	0	9	100
Total	49	57	17	20	20	23	86	100

p<0.00001

***Table 3*. Incidence of epilepsy and the clinical picture of hydrocephalus as correlated with computer tomography (CT) examination**

Epileptic seizures	Evans' index – in CT examination of the head				
	$\bar{x}$	N	S	Min	Max
No	0.50	25	0.07	0.37	0.64
Yes	0.55	35	0.09	0.38	0.69
Total	0.53	60	0.08	0.37	0.69

p<0.013

Material and methods

Eighty-six children with myelomeningocele treated in the Department of Pediatric Neurology and Rehabilitation, Medical University of Białystok, were recruited for the study. There were 44 boys and 42 girls at the age of 1-17 years (mean 7±4.4 years). The patients were divided into groups (thoracic, lumbar and sacral myelomeningocele) following Sharrard's classification. Thoracic myelomeningocele was detected in 24 children (28%), lumbar in 53 (62%) and sacral in 9 cases (10%). Hydrocephalus occurred in 100% of the patients with thoracic myelomeningocele, in 75% with lumbar, and in 67% with sacral region affected.

Electroencephalography (EEG)

EEG examination was performed at the Department of Pediatric Neurology and Rehabilitation, Medical University of Białystok, in conformity to the international standard [12,13].

Statistics

The t-Student test and chi-square test were applied for analysis.

Results

The most numerous group consisted of 53 (62%) patients with lumbar myelomeningocele. The thoracic location was found in 24 (28%), while sacral in 9 (10%) children. The ventriculoperitoneal shunt valves in the treatment of hydrocephalus were inserted in 70% of the patients. The correlation found between hydrocephalus and the use of the valve was significant at p<0.00001 (*Tab. 1*). In the thoracic myelomeningocele group, the shunt system was replaced more than once in 14 (58%) children, and once in 7 (29%) patients (*Tab. 2*). In children with lumbar myelomeningocele, the drains were replaced more than once in 6 (11%) patients, while once in 10 (19%). The number of replacements showed a significant correlation with myelomeningocele location (p<0.00001) and was higher among the patients with the thoracic type. There was a statistically significant difference between the groups with respect to the Evans' index in computer tomography (CT) examination of the head (p<0.013) (*Tab. 3*). The mean value of this index in the non-epileptic group was 0.50, in the epileptic group 0.55. Among the children who did not undergo drain insertion procedure, 44 (90%) were non-epileptic (*Tab. 4*). Epilepsy was observed in 18 patients after a single shunt replacement and in 4 children subjected to more than one revision. The incidence of epilepsy was found to depend on the frequency of the replacements. The relationship was statistically significant

***Table 4*. Incidence of epilepsy and revision of the drainage system**

Revision of the drainage system	Incidence of epilepsy				Total	
	Absent		Present			
	N	%	N	%	N	%
No revision	44	90	5	10	49	100
Once	13	42	18	58	31	100
More than once	2	39	4	67	6	100
Total	59	69	27	31	86	100

$p<0.00001$

at $p<0.00001$. Generalized changes in EEG recording were found in 53 (62%) patients, including 19 (79%) with thoracic myelomeningocele, 28 (53%) with lumbar and 6 (66%) with sacral myelomeningocele. The relationship between generalized changes in EEG and myelomeningocele location was not statistically significant. The frequency of generalized changes was not correlated with the location of myelomeningocele. The changes in the left temporal region in the respective types of myelomeningocele showed similar frequency in 8 (15.4%) children with lumbar myelomeningocele, in 4 (16.7%) with thoracic myelomeningocele and in 2 (22%) with sacral myelomeningocele (data are not shown). Those located in the frontotemporal region ($p<0.0067$) and in the right temporal region ($p<0.0314$) were found to correlate positively with the degree of spinal cord injury. They were most common in patients with thoracic myelomeningocele (8 patients; 38.3%), less common in children with the lumbar type (5 patients; 9.6%) and were observed only in one patient with sacral myelomeningocele. Abnormalities in EEG recording in the frontotemporal region were detected in 7 children (29%) with thoracic and in 3 (5.8%) with lumbar myelomeningocele.

Discussion

The EEG examination revealed a marked prevalence of generalized changes for all drains in thoracic and thoracolumbar myelomeningocele. A relationship was observed between location of myelomeningocele and the occurrence of changes in the frontotemporal and right temporal regions in EEG recording; changes of this type most frequently occur in thoracic myelomeningocele, being more seldom in the lumbar type. EEG recordings showed abnormalities of the basic action, including disturbed frequency, amplitude and spatial organisation, with myelomeningocele located in the upper thoracic and lumbar segments. Our results are in agreement with those of Battaglia et al. [7,11], who have confirmed the usefulness of EEG examination in the prognosis of the development and treatment of epilepsy accompanying myelomeningocele.

The brain-damaging factor also contributes markedly to abnormal EEG recordings [6,14]. A rapid action may cause substantial brain dysfunctions, which take longer to compensate. When the action is slower the adaptive mechanisms allow normal functioning of the brain and do not change the bioelectrical activity at the disease onset [15]. Changes in EEG recording differ between acute and chronic pathologies and depend on their intensification, duration or remission. According to Kośląc-Folga [15], EEG-localized changes are most frequently recorded in hydrocephalus.

Marszał et al. [16] emphasize that epilepsy is the most frequently diagnosed childhood neurological condition, with its physical, psychological and psychosocial sequels. The risk of epileptic seizures is an important obstacle to implementing rehabilitation practices and physiotherapeutic methods, as most epileptic patients are disqualified from electrotherapy, magnetotherapy or swimming group activities. In our group of patients, the decision to start a long-term antiepileptic therapy was made once the type, duration and frequency of epileptic seizures as well as precipitating factors had been established. We found epilepsy in 58% of patients after a single replacement of the drainage system and in 67% of children who underwent more than one replacement. In children with lumbar myelomeningocele, the system was replaced once in 19% and more than once in 11% of cases. Generalized seizure-like changes were recorded in over 79% of thoracic myelomeningocele children, while statistically significant correlations were noted for changes in the right temporal and frontotemporal regions. This group included the highest percentage of epileptic patients, which is consistent with data reported by other authors [17]. EEG examination is still very useful in the diagnosis of the form and character of epilepsy, allows monitoring of its course and therapeutic effects and evaluation of the basic action [16]. Our results are consistent with a report of Klepper et al. [10], who performed a retrospective analysis of 182 patients with hydrocephalus and shunt insertion, finding epilepsy in 20% of them. Epilepsy was also evaluated with respect to hydrocephalus etiology (posthemorrhagic, postinflammatory, associated with myelomeningocele or of unknown etiology). The authors revealed that early insertion of a ventricular drain and etiology of internal hydrocephalus were associated with a higher risk of epilepsy. No correlation was found between the number of ventricular drainage revisions, type of shunt valve or gender.

Conclusions

1. Generalized and focal changes revealed by EEG usually occur in patients with high location of myelomeningocele.
2. EEG is useful in the diagnosis of epilepsy and its prognosis among children with internal hydrocephalus accompanying myelomeningocele.
3. Dysfunction of the drainage system leading to enhanced

intracranial pressure and brain injury may be the cause of epileptic seizures in children with myelomeningocele and internal hydrocephalus.

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